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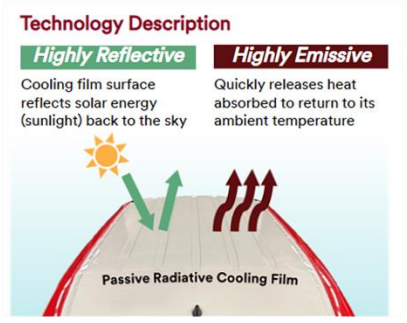
3M™ Passive Radiative Cooling Film

The phenomenon of radiative cooling has been known for centuries. Ancient Middle Eastern civilizations harnessed the power of passive radiative cooling (PRC) to make ice by pouring water into a shallow pool at sunset. The following morning, they collected the ice that formed. Even though the ambient temperature stayed above freezing, the pool itself would grow colder than the surrounding air as the water radiated heat into the sky.

How exactly does it work? During the day, radiation from the sun heats the earth's surface and the air near the ground, creating our daily ambient temperatures. As the sun sets, objects on earth stop absorbing external radiation and emit thermal energy back into the surrounding environment. In the absence of any cloud cover, a lot of that radiation escapes into space. This is the reason temperatures drop more on a clear night than on a cloudy one. This also explains why you can wake to frosty car windows or frost on the grass even at temperatures above freezing. When the sun comes out, the frost melts and everything starts absorbing heat again.


Technology Description
Highly Reflective
Highly Emissive
Cooling film surface reflects solar energy (sunlight) back to the sky
Quickly releases heat absorbed to return to its ambient temperature
Passive Radiative Cooling Film

Product Technical Features:

- Up to 92% reflective and 83% thermally emissive
- Cooling Power = 50-150W/m2 *depending on location and time of year
- Thickness = maximum 200 microns
- Anticipated 10 years product lifetime

Key Benefits:

- Operational 24/7.
- Delivers substantial electricity savings
- Consumes no water
- Retrofitting it to existing surfaces is simple
- Silent

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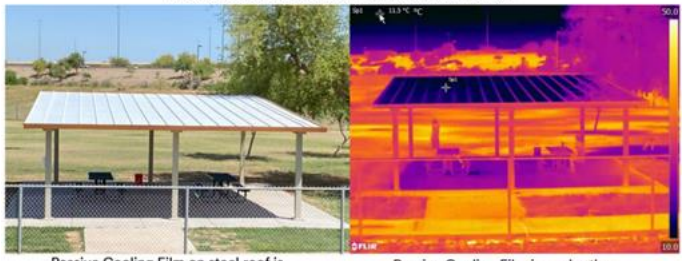
Real-World Examples:

A simple test of the effectiveness of PRCF is using a thermal camera to measure temperatures. In the example below, on a sunny September day in Minnesota with an air temperature of 72F, a thermal camera was used to capture the temperature of the hood of a car (135F), the temperature of a white painted metal panel (82.6F), and the temperature of the metal panel with PRCF applied to the surface (69.6F). The PRCF cooled below air temperature.

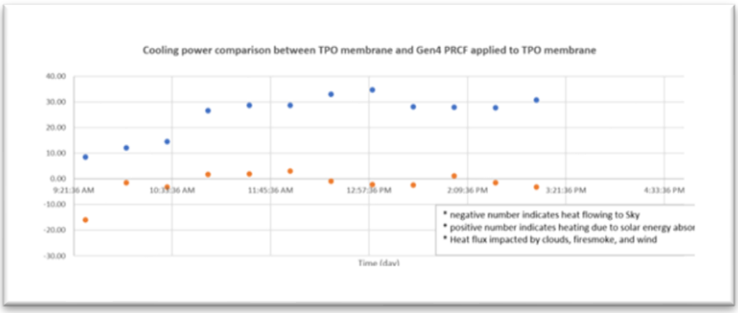
A second example in Phoenix, Arizona shows a park shade structure, with a metal roof. PRCF was applied to the top of the structure and a Infrared camera shows how much cooler the roof is than the surrounding area (dark blue = cool, dark orange = hot). Many buildings currently have white-painted metal, or white TPO membranes roofs. While these are effective compared to a dark roof, PRCF does not absorb heat, while other materials do, and can even emit heat, thus cooling the building. Below are the results of an experiment between PRCF and a white TPO membrane. Throughout the day, the PRCF consistently rejected heat from the sun and cooled the building vs the white membrane

Passive Radiative Cooling Film on Park Shelter (Ramada) Roof
Project in partnership with ASU on Phoenix City park shelter
*Images and data provided by Prof. David Sailor of ASU

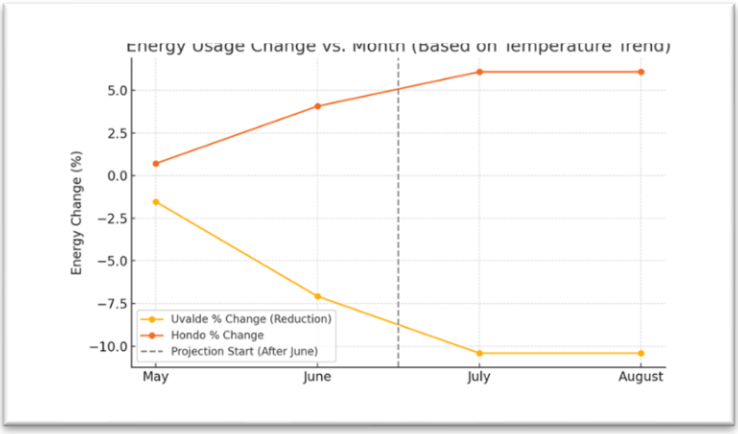


Passive Cooling Film on steel roof is 20-30F cooler than original painted steel roof.

Passive Cooling Film is cooler than surrounding environment and has a net cooling effect on ambient air.



Electrical and Telecommunication boxes are becoming common across our landscape. The gray or green boxes tend to blend into their environment, so you may not even notice them. They are designed to protect the delicate electronics from the elements, but because of the sun's heat and the heat from the internal systems, these boxes can get very hot inside and negatively impact the electronics being protected. In a side-by-side experiment, the PRCF reduced the heat inside the box by 20F and reduced the energy usage due to an on-board AC system by up to 20%.



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Potential Cooling Applications:

PRCF should be considered for any outdoor application where heat/cooling is a challenge. These include boxes that enclose and protect electronics/telecommunications, data centers, batteries and buildings or structures.

Factors Affecting Film Performance

The actual performance life of the film can be affected by:

- Selection and preparation of the substrate
- Application methods
- Cleaning or maintenance methods
- Exposure conditions
- Weather and climate
- Substrate temperature
- Insulation or thermal conductivity of the substrate

Material Application

For optimal results, consult with 3M and the installer for film application, ensuring proper surface preparation and cleaning. Potentially suitable substrates include:

- Stainless steel
- Bare aluminum
- Galvanized sheet metal (prime and paint)
- Painted metal
- Rigid plastics
- Thermoplastic polyolefin

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Developmental Status Notice

3M Passive Radiative Cooling films are 3M developmental products. They are currently available for sampling on a limited basis and are provided only for market and technical evaluation. The future availability, formulation, performance properties, and pricing of the material(s) are not guaranteed and are subject to change.

Technical Description

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Science.
Applied to Life.™

Passive Radiative Cooling Film is a 3M developmental product. It is planned to be commercially available in 2026

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